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*Photographic Studies of the Electric Arc.* By N. H. BROWN, Ithaca, N. Y.

*On the Efficiency of Condensers.* By PROFESSOR E. B. ROSA and ARTHUR W. SMITH, Middletown, Conn.

THE authors give results determined by their resonance method, which was described at the Detroit meeting.

*A Calorimetric Determination of the Energy Dissipated in Condensers.* By PROFESSOR E. B. ROSA and ARTHUR W. SMITH.

*The Effect of Fibrous Structure in Iron on its Change of Length when Magnetized.* By E. RHOADS, PH.D., Baltimore, Md.

*Notes on the Effect of Silicon on the Magnetic Permeability of Iron.* By PROFESSOR F. C. CALDWELL, Columbus, Ohio.

IT was found that the permeability increases with the amount of silicon present in the iron.

*On the Measurement of Electrical Oscillations of Short Period and their Absorption by Water.* By PROFESSOR A. D. COLE, Granville, Ohio.

THIS is a continuation of the work which was reported by Professor Cole to Section B at Buffalo.

*An Acoustical Micrometer.* By J. O. REED, PH.D., Ann Arbor, Mich.

ITS principle consists in measuring the amplitude of vibration of a stretched membrane.

*Polarization in the Zn — H<sub>2</sub>SO<sub>4</sub> Cell.* By PROFESSOR W. A. ANTHONY, New York City.

AFTER an extended research into the effect of saturating the acid with hydrogen, oxygen and carbon dioxide, Professor Anthony concludes that what is called polarization is not due to the accumulation of hydrogen, but to the fact that the oxygen originally dissolved in the acid and condensed on the plates has been used up.

*The Heat of Fusion of Ice Determined in Electrical Units.* By PROFESSOR E. L. NICHOLS, Ithaca, N. Y.

*The Electrical Resistance of Lead Amalgams at Low Temperatures.* By G. W. GRESSMAN, Ithaca, N. Y.

THE most striking fact reported in this paper is the sudden decrease in resistance upon solidification, the resistance of the solid amalgam being sometimes as low as one-fifth of the resistance of the fluid amalgam at its freezing point. If the thermo-electrical explanation—based on heterogeneity—of excessively high resistance of alloys is correct one would expect an increase of resistance upon solidification, for it is then that the alloy becomes heterogeneous.

N. ERNEST DORSEY,  
Press Secretary.

#### THE ADVANCE OF PSYCHOLOGY.\*

THE American Association for the Advancement of Science, when it first met fifty years ago, had no place for anthropology nor for psychology. Science has its origin in the practical needs of society. In a new country of great area and rich resources the energies of its people were directed to invention and exploration. The spirit of Franklin led to the development of railways, steamboats and telegraphy, to the building of cities and the search for mines.

But not only in America and in the case of the anthropological sciences have fifty years brought great changes. Science has become a leading factor in modern life by the rapidity rather than by the duration of its growth. Our own revered Dr. Hall might have talked with Herschell, who could almost have touched the hand of Newton. Newton was born the year that Galileo

\*Address of the Vice-President of Section H—Anthropology—of the American Association for the Advancement of Science, August, 1898.

died. If Copernicus had lived to extreme old age he might have handed the *De Orbium Celestium Revolutionibus* to Galileo. While the whole history of science is thus nearly spanned by five lives, modern science is scarcely older than our Association. It was only in the decade of its foundation that the doctrine of the conservation of energy was announced, while the *Origin of Species* was published in the year of our eleventh meeting. If the physical sciences, as we now understand them, are scarcely more than fifty years old, and the biological sciences are only forty years old, the anthropological sciences are still younger. Perhaps these are now in the condition of the physical sciences before they had become truly exact, of the biological sciences before they had become truly genetic.

It is easy to prophesy after the event, and from our present point of view science in its history appears to have followed a necessary course. The phenomena of the physical world are stable and readily subject to experiment and measurement; their control is essential to material progress. It is, therefore, no wonder that the physical sciences should have preceded the biological sciences in their development. Far more complex, transient and inaccessible to experiment even than the phenomena of living beings are men, they themselves and their deeds—sciences of these things must come late. As man has been evolved from simpler forms of life, and these were preceded by a lifeless earth, so the sciences dealing with man, with life and with matter must be based one upon the other. The history of science is, therefore, full of promise for the student of anthropological science. We may grant the past to others and claim the twentieth century for our heritage. Perhaps our Copernicus, our Newton, our Lavoisier, our Darwin is one of the younger members of this Section.

It may, however, be that the subject-matter of the anthropological sciences is such that they will proceed without catastrophe. The form of the earth is altered by earthquakes on occasion, but every day it is molded to a greater degree by less obtrusive agencies. In the making of the anthropological sciences by the collecting and arranging of facts, by discovery and by generalization, we have every reason to be satisfied with the part taken by America and by this Association. In many sciences we must at once yield the leadership to older nations. In the youngest of the sciences we at least stand on terms of equal service. It was perhaps by special providence that last year's meeting of our Association was presided over by an anthropologist, but this year we chose to celebrate our fiftieth anniversary under a member of this Section. That this Section should have supplied three of our last five presiding officers and our permanent secretary for twenty-five years; that the British Association should have come to America to establish its Section of Anthropology and on its second visit should have chosen an anthropologist for its president—these things we may at least regard as an omen of the place of anthropology in the science that is to be and of the place of America in anthropology.

While anthropology, largely owing to the richness of the material at hand and to the great Bureau of American Ethnology established to investigate this material, has come to such fruition in America, psychology has also shown great vitality. Unlike anthropology, psychology is distinctly a university discipline. For reasons chiefly theological, ethical and educational, mental and moral philosophy had been taught from the foundation of our colleges by the president of each institution to all students. It happened that at the same time that psychology had developed into a science, the college president became an executive

officer, no longer chosen as a matter of course from the clergy, having neither time nor training for the teaching of mental science. There was thus an empty place which the modern psychologist was prepared to fill. Further, the rapid development of the college into the university with elective courses permitted psychology to compete on equal terms with the older sciences, and the result has been its secure establishment in the university. Indeed, psychology, touching with one hand philosophy, the humanities and the historical and political sciences, while with the other hand it reaches toward the natural and exact sciences, bids fair to become central. Thus, at Harvard, Professor Münsterberg's elective course in empirical psychology was this year followed by 365 students. At Yale Dr. Scripture's course in physiological and experimental psychology was elected by 138 students. There were last year given by American universities 18 doctorates with psychology as the major subject—more than in any science except chemistry, six times as many as in astronomy and nine times as many as in anthropology.

Psychology, though its recent development has been so rapid, is not a new science; it should rather be regarded as one of the oldest of the sciences. Under the great dynasty of philosophers—founded in Greece, not extinct even during the Dark Ages, re-established after the Renaissance—all the sciences were developed. From Aristotle to Kant the history of philosophy is in large measure the history of science. But as the domain of knowledge became too great to be ruled by a single mind it must needs be divided into the principalities that we call the sciences. From the beginning psychology has been the favored nursling of philosophy, and, as the other sciences were taken from it, all the more did it cherish that which was left. In Great Britain Locke, Berkeley and Hume and their Eng-

lish and Scottish successors to the present time have been at once students of philosophy, and of psychology. The same may be said of Herbart, Lotze, Wundt and many more in Germany and in France. In our own country to-day we find many of our leaders—James, Ladd, Royce, Dewey, Fullerton and others—professing equally philosophy and psychology.

Psychology, under the guidance of philosophy, became at times somewhat schematic and unreal, though never I think unfruitful or regressive. It needed, however, to be cross-fertilized with the natural sciences. These sciences, in their development, could not ignore the senses and the mind. Perceptions are parts of a physical system, but they are also parts of an individual consciousness. Newton not only analyzed light, but also named seven colors; Dalton found that he was blind to certain of them; Young invented a theory to account for their combinations; von Helmholtz reviewed the phenomena in one of the greatest of books. Physiology on its side could not study the senses and brain while ignoring the functions that they subserve, and it was found that the methods of natural science could be applied in psychology. The zoologist could not neglect the mental life of animals and the place of consciousness in evolution. Darwin wrote not only *The Origin of Species*, but also *The Descent of Man* and *The Expression of the Emotions*, and was the first to study the development of the child's mind.

The subject-matter having been supplied by philosophy and the methods by natural science, the way was made ready for the establishment of a science of psychology. This we owe largely to the intellectual patience of Germany, tired at last of the Hegelian metaphysics. Lotze published his *Medizinische Psychologie* in 1852; Fechner his *Elemente der Psychophysik* in 1860; Wundt his *Menschen und Thierseele* in 1863, and his

*Physiologische Psychologie* in 1874. Lotze and Wundt were doctors of medicine; Fechner was a professor of physics; they were all deeply interested in philosophy. Psychology, as pursued to-day, is deeply indebted to these three, perhaps chiefly to Wundt, who, continuing his services, founded in 1879 the first laboratory of psychology, and established in 1883 a journal for the publication of its investigations. Following and leading this psychological movement we find in Germany men such as Stumpf, Lipps, Ziehen, Müller, Ebbinghaus and many more. One of them—Münsterberg—has come to us, while Höfding, of Denmark, may be included in the same group. Physiologists, such as Hering, Aubert, Preyer, Flechsig, Exner and von Kries, and physicists, such as von Helmholtz, Mach and König, may reasonably be claimed, in part at least, for psychology.

In France a philosopher, as Cousin, or a man of letters, as Taine, may have accomplished somewhat, but modern writers and workers, as Ribot and Binet, have been largely influenced by Germany. France has, however, made two independent contributions of importance, though in both cases chaff has been mixed with the grain. These are, on the one hand, abnormal and pathological psychology and, on the other hand, individual and social psychology. In Italy the names of Lombroso and Mosso remind us of work in criminology and in physiology that has become important for psychology, as is also the case with the histological work of the Spaniard, Ramon y Cajal. In Russia performance waits on promise.

Great Britain has developed a modern psychology without breaking with its traditions. It has always been a land of great individuals, and Locke, Berkeley and Hume have found worthy successors in Bain, Ward and Stout, to mention only three living psychologists belonging to

three different generations. Darwin, Huxley and Spencer, while establishing the theory of evolution, gave mind its due place, Spencer having concerned himself especially with mental and social evolution. Romanes and Lloyd Morgan have directed attention to the study of animal intelligence, while Galton's contributions to anthropometry and heredity have exhibited great originality. Experimental psychology has not made much headway in Great Britain. They have let us take from them Titchener; so he must count for America. The first laboratory, at Cambridge, was founded by me, and maintains a humble existence. Within a year a laboratory has been founded at University College, London, and Oxford has at least awakened to the existence of experimental psychology to the extent of decreeing this summer that it shall *not* be taught under a newly established lectureship of mental philosophy.

This American Association is naturally most concerned with what has been accomplished for psychology in America. The history of psychology here prior to 1880 could be set forth as briefly as the alleged chapter on snakes in a natural history of Iceland—"There are no snakes in Iceland." The eminence of the theologian Jonathan Edwards is witness to the lack of any psychologist. We had only text-books by college presidents setting forth Scottish realism. Porter, of Yale, gave us the best of these books, but McCosh, of Princeton, performed a greater service by placing the aegis of theological conservatism over both organic evolution and experimental psychology.

But the land lay fallow and twenty years ago the seed was sown. James, at Harvard, began the publication of a series of striking articles, culminating in the issue, in 1890, of *The Principles of Psychology*, a work of genius such as is rare in any science or in any country. Hall, in 1883, established in the

Johns Hopkins University the first American laboratory of psychology—the second in the world\*—since transferred to Clark University. The *American Journal of Psychology*, founded by him in 1887, shows the value of the work accomplished at Johns Hopkins and Clark, while the *Pedagogical Seminar* bears witness to his influence in stimulating interest in the child's development. Ladd published, in 1887, his *Elements of Physiological Psychology*, a work that has exerted great influence both here and abroad. It has been followed by a series of treatises on psychology that have never been equalled in range and thoroughness.

Under James, Hall and Ladd and in Germany there was then trained a second generation of psychologists, and we ourselves now have our students, a third generation. The second American laboratory was under my direction at the University of Pennsylvania. The first chair in psychology was there established and courses in laboratory work were there first given. This was only ten years ago. The work at Pennsylvania is continued under Witmer, while at Columbia we have since 1890 a laboratory and a range of courses in experimental, physiological and analytic psychology which may bear comparison with those of the other sciences. Baldwin carried modern psychology, himself enlarging it as he went, from Princeton to Lake Forest and thence to Toronto and back to Princeton. The laboratory established by him at Toronto is continued under Kirschmann, while at Princeton he has founded an efficient laboratory, and by his work on genetic psychology has brought our science into fruitful relations with zoology and sociology. Jastrow, at Wisconsin, stands forward

as a leader in experimental psychology having accomplished much for the advancement of the science and the diffusion of its results. In the latter connection may be mentioned the psychological laboratory under his direction at the Columbian Exposition and the fact that almost alone he has represented psychology in this Association.

The great services for psychology of James at Harvard, Hall at Clark and Ladd at Yale were not confined to their own publications, but were also directed toward building up strong departments. Harvard, with James, Münsterberg, Royce, Santayana, MacDougal and other men in closely related departments, surpasses every other university in the world in its opportunity for psychological study and research, and there is quite as much reason for German students to come to Harvard as for our students to go to Germany. Clark, where Sanford has charge of the laboratory, may almost be said to be a university for the advancement of psychology. The laboratory at Yale, under Scripture, has shown great activity and is able to publish annually a volume of researches. Cornell, under a president who is a student of philosophy and psychology, has robbed Great Britain of its best experimental psychologist, and under Titchener the laboratory stands quite to the front, while the courses in philosophy and psychology are especially well developed. Chicago early recognized the importance of psychology. Securing Dewey and Mead from Michigan and Angell for experimental work from Minnesota, in psychology, as in other departments, its development has been marvellous. Michigan and Minnesota have found other men to continue the work, while Stanford, California, Indiana, Iowa, Illinois and all the great State universities have established laboratories and given an adequate place to psychological courses.

\* It would be more correct to regard the laboratory established about the year 1875 by James in the Scientific School of Harvard University as the world's first psychological laboratory. It was, however, nominally under physiological auspices.

It would be possible for me to give other objective proofs of the progress of psychology—the establishment, in 1894, of a second journal, *The Psychological Review*, which during the first six months of the present year published some 900 pages, all we hope contributing to the advancement of psychology; the prominent place given to psychology in our journals of education, philosophy, general science and popular literature; the widespread amateur interest in child-study and psychical research; our Psychological Association, with a membership of 102, all engaged in advancing psychology—these and other witnesses for psychology might be called upon to testify, but the development of psychology in the university has seemed to me best deserving of extended comment. Until the State shall learn to care for those who do the most for it, until those who are engaged in advancing knowledge shall work for the State and be supported by the State our universities will be the centers for research, and the position of a science in the university will measure its opportunity and fruitfulness. Very significant for psychology, therefore, is its progress in the universities of America during the past twenty years.

My remarks have been confined to the externals of psychology. Its inner history, its present content, its future outlook are not subjects that can be readily brought up and dismissed in a few words. Psychology is the most complex of the sciences. I do not at all claim that it is the most important of the sciences. The human race got on without it very well and could doubtless continue to do so. Its practical applications do not compare in importance with those of many of the sciences; it is in a way lacking in great discoveries and universal laws. But, compared with psychology, a science such as astronomy may almost be regarded as naïve. The entire known performance of the solar system and of the

fixed stars since the time of the Chaldean<sup>s</sup> is less complicated than the play of a child in its nursery for a single day. The stars are so far away, the telescopes are so big, eclipse expeditions proceed to such remote quarters of the earth, that the simplest items of information take on a dramatic interest. Atoms and molecules are so invisible, the ether is so intangible, we know after all so little about them, that it is easy to invent hypotheses that do not contradict our ignorance. The generalizations of physical science are, indeed, the greatest achievements of the human intellect, but the intellect, by which and for which these generalizations have been created, when itself made the subject-matter of a science, is complex beyond those sciences which are its offspring.

Psychology does not, of course, claim as its subject-matter all ‘that is in heaven above, or that is in the earth beneath, or that is in the waters beneath the earth.’ The physical and natural sciences, language, literature and the fine arts, industries and institutions have, it is true, their origin and end in the mind, but this does not turn them into departments of psychology. The physicist no more needs to concern himself with the mental processes leading to his discovery than does the hen with the processes preceding the laying of its egg. The kind of novel called psychological is by no means a product of science. The enjoyment of art decreases as we analyze its products. Scientific prevision and guidance have scarcely more to do with the rise and decline of institutions than with the rise and decline of the sun in the firmament.

Still I do claim that there is no department of knowledge or activity which does not have an aspect that concerns psychology, and while hitherto it is psychology which has learned from sciences preceding it in their development, the time will come, and perhaps has now come, when every

science must take into account the facts and theories of psychology. The increase of knowledge which has caused the creation of the separate sciences is now leading to further specialization, but not in the sense of one science more completely ignoring the others. Rather we have at present well established sciences, such as astrophysics, physical chemistry, biology and others which take their subject-matter from two or more of the older sciences. It is probable that students in increasing numbers will take up the inter-relations of psychology with other sciences. Indeed, this tendency is already well marked. Mathematics is necessary as a tool for psychology, while conversely several books have recently been published concerned with the psychological presuppositions of mathematics. The fundamental concepts of mechanics have been treated as mental products by Mach, Pearson and others. At the present moment the Vice-President is giving, before the Section of Physics, an address on the perception of light and color, while the same subject was chosen by Sir George Stokes last month for the subject of his address before the Victoria Institute. Physics is, however, leaving to psychology vision, hearing, etc., though in the meantime new departments, destined perhaps to become new sciences—represented by the great works of von Helmholtz, *Physiologische Optik* and *Tonempfindungen*—are being created, which draw their materials in equal measure from physics, from physiology and from psychology. Errors of observation, the personal equation, the relation between mental and physical intensity, are subjects where the investigations of the psychological laboratory must be applied in astronomy and the other physical sciences. Chemistry, geology and botany perhaps stand most remote from psychology. Still, if physiology is in large measure the chemistry of living tissues, chemistry may be brought into intimate

relations with psychology. Geology and anthropology are closely related, while physical geography is especially concerned with the relations of man to the earth. Many of the problems of evolution, so essential for psychology, are best studied in plants, and the applications of botany in agriculture, etc., are determining factors in the evolution of man.

Physiological psychology is already accepted as a distinct discipline, while zoology and psychology are equally intertwined. It is impossible to separate physical and mental evolution—witness the writings of Darwin, Spencer, Huxley, Romanes, Cope, Morgan and many more. Under the classification of this Association anthropology and psychology are included in one section. Several of our leading members would make psychology a branch of anthropology, while psychology regards ethnology and archæology, on the one hand, and somatology, on the other, as contributing much to its subject-matter. Sociologists find it somewhat difficult to disentangle their field from that of psychology.

If we turn to the departments of knowledge not represented in this Association—the humanities—we find psychology to be a connecting link between them and the physical and natural sciences. If we regard the professions—medicine, law, theology, teaching, journalism—we find that their products when systematized into sciences give to psychology and take from it. Literature and the fine arts, both in their origin and in their end, may be studied as departments of psychology, though it does not appear that psychology has as yet been of great service to them.

I may illustrate the inter-dependence of psychology and other sciences by a definite example. Much is being written just now regarding the relation of consciousness to the brain. The question is: Do perceptions, thoughts, feelings, volitions stand in causal



interaction with the brain, or are they an epiphenomenon, accompanying changes in the brain but not influencing them? Are our ordinary actions complex reflexes due to physical stimuli and the structure of the nervous system, or are the changes in the brain that precede movements initiated and directed by consciousness? The question is one of facts, that should be settled by scientific methods; and the solution will by no means concern psychology alone. The two greatest scientific generalizations of the present century are the conservation of energy and evolution by survival of the fit. Now, if consciousness alters, however slightly, the position of molecules in the brain the fundamental concept of physical science must be abandoned. If consciousness have no concern in the actions of the individual we have one of the most complex results of evolution developed apart from the survival of useful variations, and the Darwinian theory has failed. Surely both the physicist and the biologist must watch the steps toward the solution of a problem that concerns them so nearly.

The world is one world; every part of it is in relation to every other part, and each part consists in these relations. As a hand cut off from the rest of the body is no longer a hand, as a man apart from other men is no longer a man, so each science and each scientific fact and law has its value and even its existence in its relation to the totality of knowledge and of life. Psychology has become an integral part of modern science; it gives and takes with a free hand. A parvenu among the sciences, it is self-conscious and knows its obligations and its limitations; but its position in the body scientific is henceforth secure.

I have said that psychology is in a way lacking in great discoveries and universal laws. If I were addressing an audience of psychologists it might be desirable to consider whether this is due to the subject-

matter or only to the immaturity of our science. Under present circumstances it is perhaps better in part to question my own statement. Columbus discovered a new world; Copernicus discovered innumerable worlds; but Descartes discovered, or at all events invented, the soul. Which after all was the greater scientific advance? Columbus did not foresee four hundred years of history, the present unequal conflict of a powerful nation with a declining civilization. Descartes' ideas of the relation of mind and body are not ours. But is not the very subject-matter of psychology one of the greatest discoveries of modern science? To unite strict idealism with strict materialism; to give consciousness its central place in the universe and yet to show that each change in consciousness is correlated with a change in the nervous system—this I claim to be a scientific generalization comparable to that of the conservation of energy or of organic evolution.

Minor but clear-cut discoveries in psychology have not been lacking—witness color-blindness, individual types of mental imagery, the dependence of emotion on reflex bodily movements, hypnotism, etc. Neither are quantitative formulas denoting relations among mental states or between mental and physical change lacking. Recent researches on subjects such as the perception of space, illusions of sense, color-vision, the time of mental processes, memory, fatigue and many more represent scientific advances as definite, interesting and important as those of physics or of zoology. Psychology has been able to adopt the quantitative methods of exact science and the genetic methods of natural science, while its older methods of description and analysis witness an insight and acuteness unrivaled by any other science.

I have said that the practical applications of psychology do not compare in importance with those of many of the other sciences.

Here again, while a society of psychologists might properly discuss the causes of this limitation, in an address confined to generalities, it may be more profitable to point out that daily life consists in the application of such psychological knowledge as is at hand. How could Bismarck and Gladstone direct contemporary history except by superior insight into the way men act and the methods of influencing their actions? What have Wagner and Browning done except excite interest and emotion? The conduct of every profession and of every business is chiefly based on the adjustment of thoughts, feelings and actions. Systems of government and education are simply methods for controlling and directing the human mind. Now, of course, all this is done by the rule of thumb entirely uninfluenced by psychology as a science. The savage who kills a bird with a stone is not thereby shown to be a zoologist and a physicist. Still he does have a kind of knowledge of the habits of animals and of the laws of projectiles, whence have developed the sciences which, in the course of time, have turned back to daily life those applications of science in which modern civilization consists. Whether the history of the material sciences will be repeated in the case of the mental and social sciences it is not possible to say or to gainsay. There are at present indications of the application of psychology in the treatment of diseases, in education and in other directions. Evolution, careless of the individual, has proceeded with boundless waste; certainly we are now interfering with its course for our benefit. It may be that some day the applications of material science will be subordinate to those of psychology.

These things lie on the knees of the gods. What the future will bring we do not know, but the past is ours. When we regard the fifty years of this Association or the century now ending we cannot fail to

see that it has been an era of science. German music, English poetry, the modern novel—these are great achievements, but scarcely comparable to the forward movement in science. The older sciences have been reformed and new departments have been established. But amid all this scientific progress nothing has been more notable—at least from my own partial point of view—than the development of psychology into a science rivaling in activity and fruitfulness the other great sciences.

J. McKEEN CATTELL.

COLUMBIA UNIVERSITY.

#### THE SENFF ZOOLOGICAL EXPEDITION TO THE NILE VALLEY.

THE chief object of the expedition was to procure the life-history of *Polypterus* and its bearings upon the problem of the relation of the Crossopterygian fishes to the Amphibia. In the last few years the former theory that Amphibia sprang from Dipnoan fishes has gradually given way to the present view that *Dipnoi* are to be regarded as parallel to Amphibia from a common Crossopterygian origin.

Several very successful expeditions have been recently sent out to procure material for the embryology of Dipnoans, notably that of Richard Semon from Jena and that of Graham Kerr from the University of Cambridge. The former secured the complete life history of *Ceratodus*, and the latter brought back the embryology and complete life history of *Lepidosiren*, a South American form. In the meanwhile nothing has been done upon the development of *Polypterus* because of the exceptional difficulties which stood in the way of procuring material. The fish is abundant in the unhealthy equatorial zone of Africa, being recorded on the West Coast rivers as well as in Central Africa. It is also found in the Nile, but the Upper Nile, where it probably occurs in greatest abundance, has not been open to